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Comparison of body balance in active elderly and young adults

Comparação do equilíbrio corporal em idosos ativos e jovens adultos

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Abstract

Introduction: The aging process generates changes in physiology and in the performance of daily living activities. **Objective**: To compare the postural control of active seniors and young adults with and without visual information, by means of a force platform. **Method**: A cross-sectional exploratory study was carried out with 66 subjects divided into two groups: G1, young adults with an average age of 20.33 (1.86) years; and G2, active elderly individuals with an average age of 67.42 (6.2) years. **Results**: The displacements observed with the use of vision were 0.84 cm (AP) and 0.63 cm (ML) in the younger group and 1.33 cm (AP) and 1.02 cm (MP) in the group of active seniors. Without the use of visual information: 0.95 cm (AP) and 0.68 cm (ML) in the young group and 1.46 cm (AP) and 1.21 cm (ML) in the elderly group. The average displacement exhibited significant differences ($p<0.001$). **Conclusion**: In spite of exercising regularly, the elderly group showed greater fluctuations with and without visual information.

Key words: Age groups; Elderly; Postural balance.

Resumo

Introdução: O envelhecimento gera mudanças fisiológicas e no desempenho nas atividades da vida diária. **Objetivo**: Comparar o controle postural de idosos ativos e jovens adultos, com e sem informação visual, por meio de uma plataforma de força. **Método**: Realizou-se estudo exploratório transversal com 66 indivíduos divididos em dois grupos: G1, jovens com uma idade média de 20,33 (1,86) anos; e G2, idosos ativos com 67,42 (6,2) anos. **Resultados**: Os deslocamentos observados com o uso da visão foram 0,84 cm (AP) e 0,63 cm (ML), no grupo de jovens; 1,33 cm (AP) e 1,02 cm (MP), no de idosos ativos. Sem o uso de informação visual: 0,95 cm (AP) e 0,68 cm (ML), no grupo de jovens; 1,46cm (AP) e 1,21cm (ML), no de idosos. O deslocamento médio apresentou diferença significativa ($p<0,001$). **Conclusão**: Apesar da prática de exercício físico regular, os idosos apresentaram maiores variações posturais com e sem informação visual.

Descritores: Equilíbrio postural; Idosos; Grupos etários.

Introduction

With advancing age, various biological losses occur in the most diverse systems. Among these, three have direct influence on the maintenance of the body's balance – the proprioceptive system, the vestibular system, the visual system, and their affections may cause temporary imbalance, which disappears with the compensation mechanism, or may even be permanent, depending on the gravity of the losses[1].

In this context, the importance of the visual system for the control of balance has been the focus of several studies[2-4]. This system makes use of visual stimuli to provide information about the environment, direction of movement, and velocity of the body itself, and this in relation to the objects in the environment[5,6].

Postural sway increases with the withdrawal of visual information and may be related to the high reliance on visual information as to problems in processing visual information for postural control. Moreover, studies have demonstrated that postural sway is greater in the elderly, compared to younger adults[7,8].

Among the changes occurring with aging, there are those relating to the structure of the eyes. With advancing age, less light is processed by the retina, and there may be loss in sensibility of visual contrast too, causing problems in contour and depth perception[9]. This information is important for posture control and may be decisive for its maintenance, as demonstrated by a study that evaluated patients with senile cataract before and after surgery. These data suggest that even lower visual acuity interferes negatively with postural balance and that vision recovery leads to improvement in balance and consequently in the quality of life of the concerned individuals[10,11].

To minimize the various losses that naturally occur with aging, especially those related to the maintenance of balance, regular practice of activities and physical exercise has been indicated[12,13]. Nevertheless, there is a lack of studies indicating differences in postural control and in the maintenance of balance in active people at different ages. Typically, studies are focused on individuals enrolled in rehabilitation programs, and physical activity variables are not controlled. Even if this concern exists in the scientific community, there are no studies addressing the issue of the interrelationships between elderly and physically active young adults as well as the influence of vision on balance performance. Based on the foregoing, the aim of this study is to compare the postural control of active seniors and young adults and the displacement of the center of pressure in anteroposterior (COPap) and mediolateral (COPml) directions during balance in young adults and active seniors, with and without use of visual information.

Materials and methods

Sampling

In total, 66 individuals of both genders were assessed using intentional rather than probabilistic sampling. The individuals were divided into two groups: young adults and elderly individuals. Table 1 presents the groups of the study (young adult and elderly), the number of individuals, the average and standard deviation of age, and the body weight and height of the individuals.

Table 1: Study groups, number of individuals, mean and standard deviation of age, body weight and height of subjects in both groups

Descriptive variables	Young	Elderly
Subjects	34	32
Age (years)	20.33 (1.86)	67.42 (6.2)
Weight (N)	672.96 (129.95)	694.48 (119.78)
Height (m)	1.76 (0.08)	1.57 (0.08)

Procedures and measures

All subjects signed a Consent Form to participate in this research, as required by the Ministry o Health's National Council of Health Resolution No. 196/1996 on research with humans.

To assess the level of physical activity, the International Physical Activity Questionnaire (IPAQ) was used. The study included subjects who were considered active and practiced more than 150 minutes of physical activity per week[14]. Moreover, as recommended by Benedetti et al.[15], due to the small sample size, besides the formal IPAQ application, individual questions were asked in an interview in order to enable a wider visualization of the daily physical activities of the evaluated individuals. Regular practice of water aerobics and walking were identified for at least six months – often twice weekly – in all evaluated individuals. Those with other practices in addition to those determined by the study were excluded from the assessments, as well as those who practiced only one of the two modalities. These standardizations occurred so that the type of exercise being performed would not act as a hindrance to body stability. Furthermore, we included only individuals practicing these modalities and excluded anyone with any of the following characteristics: musculoskeletal problems; diseases associated with vestibular problems, such as labyrinthitis; a shortened member; use of cane; dizziness. Those who volunteered to participate in the study were evaluated effectively.

Body balance was evaluated and analyzed by computer stabilography. A three-dimensional force platform (OR6-5 AMTI, Advanced Mechanical Technologies, Inc.) was used to assess the position of the center of pressure (COP) during static standing. The location of the COP expresses the position resulting from the ground reaction force, indicating the neuromuscular responses to body sway due to changes in the center of gravity position[16]. COP is the point of application of the resultant vertical forces acting on the weight-bearing surface (force platform) and refers to the position measurement defined by two coordinates on the surface of the platform. These are identified in relation to the orientation of the individual standing on the platform: the anteroposterior and mediolateral direction from the signals measured by the force platform. The COP position is calculated at each instant of movement, and this, in this study, was provided by:

$$COP_{ap} = [(My - h.Fx)/Fz]_{max} - [(My - h.Fx)/Fz]_{min}$$

Where:

COP_{ap} = coordinate of center of pressure in the anteroposterior direction;

COP_{ml} = coordinate of center of pressure in the mediolateral direction;

Mx = moment around the anteroposterior axis;

My = moment around the mediolateral axis;

Fx = anterior-posterior component of ground reaction force;

Fy = mediolateral component of ground reaction force;

Fz = vertical component of ground reaction force;

h = distance from the surface to the geometric center of the force platform.

Throughout the data collection, participants remained shoeless, in bipedal support and in the anatomic reference position. Each participant was asked to maintain an upright posture as stable as possible[17].

Data were collected on the following conditions: (1) eyes open and (2) eyes closed. In all examined conditions, individuals remained on the platform with feet apart at a distance equivalent to the width of their hips. To do this, firstly, the width corresponding to each individual was marked on the surface of the force platform so that, in all attempts, the individual would remain in the same position. In the eyes open situation, each individual was asked to stare at a point marked on the wall, two feet away at eye level, as recommended by Gandelman-Marton et al.[18]. Data from six trials were collected for each individual, three for each condition. In each trial, data were collected for 30 seconds, after stabilization of the COP, at a frequency of 100 Hz and an average taken for each subject under each condition analyzed.

During the body's balancing, the amplitude of displacement of the center of pressure in the anteroposterior (COPap) and mediolateral (COPml) directions were analyzed.

Height was measured with a stadiometer set vertically on a wall and having a resolution of 1 (one) mm, Body weight was measured by the very force platform.

Analysis

For data analysis, descriptive statistics were used. Data normality was verified using the Shapiro-Wilk test. Since data showed normal distribution, a Student's t-test for independent data was used to compare variables (COPap and COPml) between the young and elderly groups, both in eyes open and eyes closed situations. The level of significance for all tests was 5%. For the statistical calculations of all analyses, Statistica® 7.1 for Windows® was used.

Results

For the balance analysis in condition 1, values for COPap and COPml in both groups are illustrated in Table 2. All variables, comparing the young and elderly groups, under the eyes open condition, showed statistically significant differences.

When condition 2 was analyzed, all variables also showed statistically significant differences when young and elderly groups were compared. The values of COPap and COPml variables are illustrated in Table 3.

Table 2: Mean (X) and standard deviation (S) values of COPap and COPml with open eyes in the study groups

Variables (cm)	Young (34) X (S)	Elderly (32) X (S)	p-value*
COPap	0.84 (0.19)	1.33 (0.38)	<0.001
COPml	0.63 (0.17)	1.02 (0.38)	<0.001

* Student's t-test significance level

Table 3: Mean (X) and standard deviation (S) values of COPap and COPml during static balance of young adults and elderly individuals without visual information

Variables (cm)	Young (34) X (S)	Elderly (32) X (S)	p-value*
COPap	0.95 (0.24)	1.46 (0.48)	<0.001
COPml	0.68 (0.17)	1.21 (0.55)	<0.001

* Student's t-test significance level

The results of the analysis were statistically different between both groups for all variables, both with and without visual information (p<0.001). Thus, even though both groups are physically active, body balance, when compared between groups of different age, is statistically different, with higher values for older individuals with visual information (COPap=1.33(0.38); COPml=1.02(0.38)) and without visual information (COPap=1.46(0.48); COPml=1.21(0.55)).

Discussion

The main results of this article indicate that balance in the elderly varies more when compared to young adults, whether with eyes open or closed. The increase in body oscillations could be regarded as the beginning of changes in the postural control, which corresponds to the aging process. The findings in this study are consistent with the proposals of authors such as Pereira et al.[19] and Yeh et al.[20]. The authors state that static postural balance decreased over time in healthy individuals. As reported by Wieczorek[9], with aging, there is also a decline in the visual system, which is in accordance with our findings, since there was an increase in body sway of the elderly, compared to young adults (Table 3).

Thus, aging can be relevant as an aggravating factor in postural sway[20,21]. Significant changes occur in body balance after the age of 60 years. During this period, there is still a linear trend of increased postural sway, which can be seen from age 40. These considerations are in line with the findings of this study, since the elderly presented higher values in the range of displacement of the center of pressure on both proposed conditions. Teixeira et al.[17] showed that after the age of 20 years, there are already differences in body balance when manipulations are performed on the sensory systems, such as vision.

However, for Takacs et al.[22], differences between older people and adults during the maintenance of balance are not caused by structural changes of the sensory systems that occur due to the natural aging process, but rather could be related to pathological changes in one or more of these systems. The same authors also argue that only at older ages could these differences be associated with the sensory changes caused by the aging process, as these are more dramatic at older ages.

These occurrences can also be attributed to the natural aging process, which promotes decreased capacity of the somatosensory and vestibular system in the detection of body movements, which possibly, according to Figueiredo et al.[23], leads the elderly to an increased need to use the visual system for controlling the body; i.e., unlike young adults, the elderly become more dependent on vision.

When visual information is suppressed and/or manipulated, there are indications of larger body oscillations. However, due to the fact that there are differences of oscillation when all sensory systems should be interacting with each other and with the central nervous system, concerns should be greater, and investigations aimed at diagnosing the existing problems should be made. In these cases, there are possibilities for evaluating the vestibular and somatosensory system[24], since in the condition 1 case, with eyes open, there is no sensory interference.

For Liaw et al.[7], elderly individuals let themselves be influenced by the information being handled, while young people can, through more effective sensory information processing, minimize the effects of the manipulation, resulting in a reduction in its influence.

Possible causes of instability in the elderly are related to changes in the relationship between sensory information and motor action, represented by the difficulty that the elderly have integrating the most relevant information, assigning weights to each piece of information according to the context, and selecting adequate answers in order to keep the body balanced. Thus, it can be inferred that without the use of vision, the elderly have greater fluctuations than young people because of the lack of interaction between the other two systems that constitute the balance triad: the vestibular system and the proprioceptive system. During the interaction process of the sensory information, the postural control system receives available information and dynamically selects the most relevant sensory information within a specific context, aiming to generate more precise information for postural control[25]. The deterioration of these systems then starts to contribute to the decline of stability of the elderly[26].

Specifically, the practice of physical exercises on a regular basis can be thought of as a positive agent for the improvement of balance values[4]. Thus, the programs of regular physical exercises could be designed for the population with body imbalance problems[12]. Some authors argue that physical exercises are an alternative to alleviate the difficulty of body stability, since many studies show that physical activity has positive effects on postural balance[27,28]. For Treml et al.[29], physical activity promotes benefits to the sensory and motor systems by improving the functioning of the sensory channels (visual, auditory, and somatosensory) that are important to the control system. In contrast, lack of physical activity influences the overall physical fitness and coordination of the elderly and, as indicated by Teixeira[12], there is a tendency of recurrence of problems related to balance disorders, such as, for example, complaints of dizziness, and consequently poor quality of life in physical, emotional, and functional terms.

However, activities undertaken by the elderly seem to have no significant influence on balance, which suggests the need for further investigation of the effectiveness of exercise programs and practices related to the maintenance and improvement of stability.

Nevertheless, and because this is not the purpose of this study, lack of pre- and post-test evaluation is a limitation of the analysis. Thus, considerations of possible acute and chronic effects of walking and water aerobics activities are limited.

Differences are also important in order to confront the literature that relates the risk of falls with the center of pressure data, mainly in the mediolateral direction[19]. These differences, as observed in Tables 2 and 3, can demonstrate the tendency for risk of falls in the elderly population, since they present significantly higher values. Furthermore, the prevention of falls, especially in the elderly population, is a relevant and current concern[30]. Lord et al.[26] argue that many elderly individuals with a history of falls have no musculoskeletal or neurological diseases, which confirms the findings that healthy and physically active older people have higher body oscillations compared to young people. This illustrates once again that these changes become relevant, as opposed to studies by Nunes et al.[8], apart from the differences in the anteroposterior direction; they are also present in the mediolateral direction, indicating the need for evaluation of body balance and its relation to falls.

In this sense, the high level of body imbalance in elderly becomes an important piece of information for health professionals who carry out clinical assessment in this population. Especially those who apply tests that require the complete blockage of vision with this population, as, for example, in assessments of coordination, posture and gait. In addition, since this study indicated amounts of displacement of center position with active elderly individuals, the findings could be used as predictive parameters for some pathology[12].

Conclusion

The analysis of oscillations in both anteroposterior and mediolateral directions, with and without the use of vision, indicated that the behavior of variables in young adults and active elderly individuals was similar to results from the literature that analyzes sedentary individuals. The practice of physical exercise was not a differential for the presence of minor oscillations in the elderly.

Nevertheless, the differences that were found underscore the need for further investigation of the importance of somatosensory and vestibular systems for the balance of active individuals at different ages, as well as the relationships between the decline and maintenance of body stability.

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